

# The Lichens of Norfolk Island

## 2: The Genera *Cladonia*, *Pertusaria*, *Pseudocyphellaria* and *Ramalina*

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Twenty-four species in the genera *Cladonia*, *Pertusaria*, *Pseudocyphellaria* and *Ramalina* which currently grow on Norfolk Island are examined critically. Each species is described fully (including chemistry) and its distribution is recorded. *Pertusaria montpittensis* A. W. Archer, *Pertusaria nebulosa* A. W. Archer, *Pertusaria norfolkensis* A. W. Archer and *Pertusaria verdonii* A. W. Archer are described as new to science.

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### INTRODUCTION

This paper is a continuation of a series on the lichens of Norfolk Island (Elix and Streimann, 1989). The fruticose genera *Cladonia* and *Ramalina* are cosmopolitan in distribution. *Cladonia* is more common on soil and dead wood in cooler or temperate areas and thus is relatively rare in Norfolk Island (7 species). *Ramalina* is widely distributed in warm temperate and tropical regions (particularly in maritime and hinterland environments) and so is a very common corticolous genus on the island with 6 species, one of which is endemic. On the other hand representatives of the genus *Pseudocyphellaria* are found mainly in the Southern Hemisphere, and three of the four species observed on Norfolk Island have restricted Australasian distributions. *Pertusaria*, the fourth genus dealt with here, is a large genus of cosmopolitan lichens in which the species characteristically produce crustose thalli in which the apothecial development takes place within thalline protruberances. As in many subtropical areas, the genus is common on Norfolk Island, being represented by 7 species, three of which are endemic.

### COLLECTIONS AND SITES

#### Specimens Examined

Collectors and lodgement of specimens examined are as follows: *JA*E were collected by J. A. Elix and H. Streimann and are held in ANUC; *HS* were collected by H. Streimann and are held in CBG with duplicates distributed as indicated.

Twenty five collecting sites were reported previously (Elix and Streimann, 1989) and a further nine are recorded here together with corrected details for S16 (Fig. 1 shows the location of the 34 sites):

S16: *Psidium* and *Olea* infested lowland forest, Duncombe Bay Road, near entrance to Mt Pitt Reserve, 29°00'30"S, 167°56'E, 50 m, 7.xii. 1984.

S26: mixed subtropical rainforest, near Broken Pine, Mt Pitt Reserve, 29°01'30"S, 167°56'20"E, 220 m, 1.xii.1984.

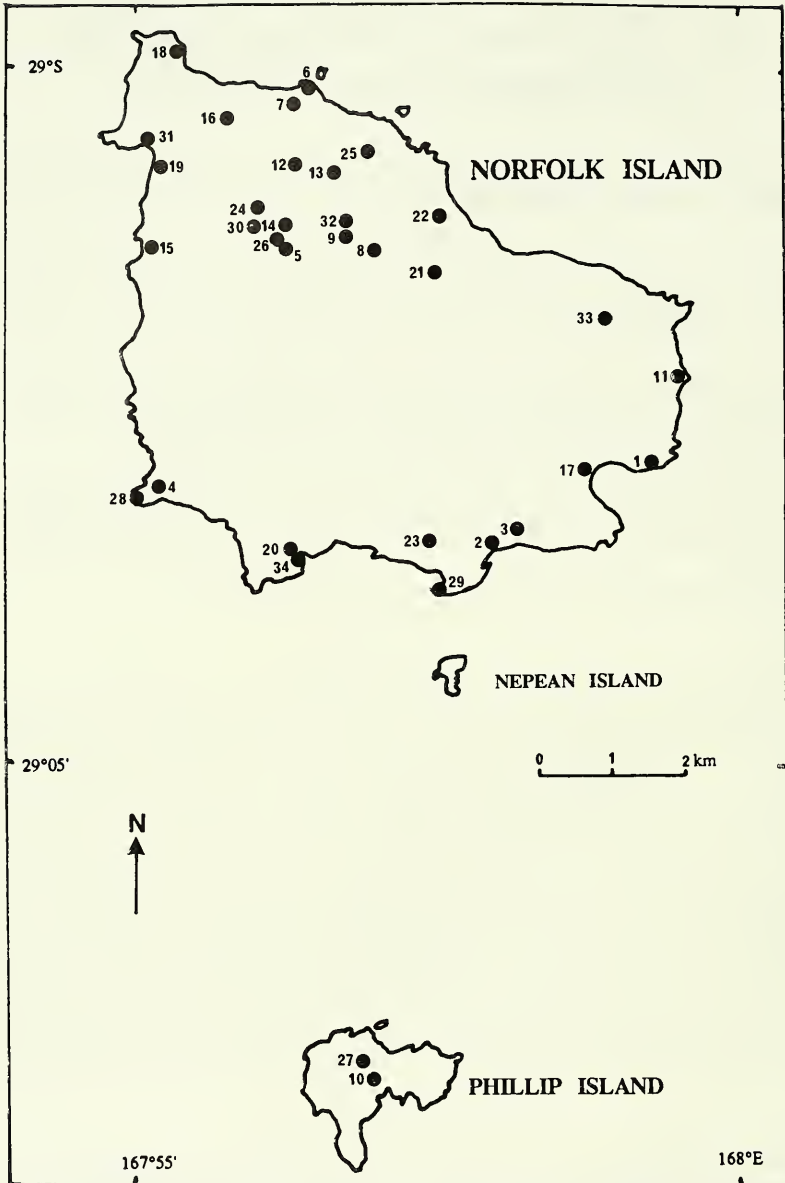


Fig. 1. Collection Sites on Norfolk Island.

S27: barren hillside with remnant *Araucaria heterophylla*, Red Road Valley, Phillip Island, 29°07'S, 167°56'45"E, 60 m, 4.xii.1984.

S28: rocky headland with mixed exotic and *Araucaria* woodland, Rocky Point Reserve, 29°03'S, 167°55'20"E, 40 m, 5.xii.1984.

S29: rocky foreshore and bay, Point Hunter and Emily Bay, 29°04'S, 167°58'E, 3 m, 5.xii.1984.

- S30: open woodland, slopes of Mt Bates, above the road opposite King Fern Valley trail, Mt Pitt Reserve, 29°01'S, 167°56'20"E, 280 m, 7.xii.1984.
- S31: grassland with scattered *Araucaria heterophylla*, Anson Bay Reserve, 29°00'30"S, 167°55'E, 40 m, 7.xii.1984.
- S32: mixed subtropical rainforest with open areas, track at end of Selwyn Pine Road, 29°01'S, 167°56'30"E, 200 m, 8.xii.1984.
- S33: open woodland, end of Stockyard Road, 29°01'30"S, 167°59'E, 65 m, 10.xii.1984.
- S34: rocks in grassland and along foreshore, Bumboras Reserve, 29°03'30"S, 167°56'20"E, 10 m, 10.xii.1984.

*CLADONIA* Hill ex Browne

**Artificial Key to *Cladonia* in Norfolk Island**

- |   |                        |
|---|------------------------|
| 1. Apothecia or pycnidia red .....                                      | 2                      |
| 1. Apothecia brown or lacking .....                                     | 3                      |
| 2. Podetia ecorticate, farinose sorediate .....                         | <i>C. bacillaris</i>   |
| 2. Podetia mainly corticate, ± granular sorediate .....                 | <i>C. floerkeana</i>   |
| 3. Podetia esorediate, squamulose, with thamnolic acid .....            | <i>C. acuta</i>        |
| 3. Podetia sorediate at least in part, lacking thamnolic acid .....     | 4                      |
| 4. Medulla P+ orange, containing psoromic acid .....                    | <i>C. subpityrea</i>   |
| 4. Medulla P+ red, containing fumarprotocetraric acid .....             | 5                      |
| 5. Podetia mainly corticate, sorediate below margins of scyphi only ... | <i>C. fruticulosa</i>  |
| 5. Podetia ecorticate and sorediate towards apices .....                | 6                      |
| 6. Podetia containing fumarprotocetraric acid and homosekikaic acid ..  | <i>C. adspersa</i>     |
| 6. Podetia containing atranorin and fumarprotocetraric acid .....       | <i>C. praetermissa</i> |

*Cladonia acuta* (Taylor) Nyl. ex Hue, *Nouv. Arch. Mus. Hist. Nat. Paris*, ser. 3,2: 32 (1890).  
*Cenomyce acuta* Taylor, *Hooker's London J. Bot.* 6: 186 (1847).

*Cladonia squamosa* var. *acuta* (Taylor) Müll. Arg., *Flora, Regensburg* 71: 19 (1888).

*Cladonia rigida* var. *acuta* (Taylor) A. W. Archer, *Muelleria* 7: 175 (1990).

**Type:** 'Islands of the Pacific' ('Pacific' on label), Hb. Hooker (FH-holotype, H-isotype); contains thamnolic, decarboxythamnolic and homosekikaic acids (Stenroos, 1988).

*Cladonia squamosula* Müll. Arg. var. *subsquamosula* A. W. Archer, *Muelleria* 6: 384 (1987).

**Type:** Australia, New South Wales, Wentworth Falls, 90 km west of Sydney, 150°22'E, 33°45'S, alt. ca 900 m, 1.vi.1985, *Archer 1751* (MEL 1048970 — holotype, NSW — isotype).

**Primary thallus** of persistent squamules, 1-3 mm long, 0.5-1.0 mm wide, subpalmately lobed, margins crenate to incised. **Podetia** arising from the upper surface of the primary squamules, simple or rarely branched, cylindrical or tapering towards the apices, 10-20 mm tall (rarely to 25 mm), 0.5-1.5 mm diam., escyphose, sterile podetia acute; podetia ecorticate and squamulose, squamules ca. 0.3 mm long near the base of the podetia, becoming smaller and isidioid, 0.1 mm long, near the apices. **Apothecia** brown to dark brown, clustered, 0.5-1.5 mm diam., terminal on podetia, the tips of fertile podetia often open to the interior; spores eight per ascus, colourless, simple, ellipsoid, 12-15 x 3-4 µm. **Pycnidia** not seen.

**Chemistry:** Thallus K+ yellow, KC-, P+ orange; containing thamnolic acid (major), homosekikaic acid (major), sekikaic acid (trace), hyperhomosekikaic acid (trace) and barbatric acid (in the apothecia).

*Cladonia acuta* is an Australasian species growing on dead wood in moist, semi-shaded positions. It is widespread in southern Australia (W.A., S.A., Tas., Vic., N.S.W.) but rare in Norfolk Island. A previous report of *Cladonia squamosa* (Scop.) Hoffm. from Norfolk Island (Riedl, 1988) may well refer to *C. acuta*, but the chemistry of the specimen was not reported and it was unavailable for examination.

**Specimen Examined:**

NORFOLK ISLAND. On stump of *Cyathea brownii*, Mt Pitt, R. Goldsack, 27.xii.1981 (NSW).

*Cladonia adspersa* Mont. & v. d. Bosch, in Miquel, *Pl. Jungh.* 4: 456. 1855 (1857).

**Type:** Indonesia, Java, ad terram muscosam, ad basin truncorum, *Junghuhn & Teymann* (PC, here selected as lectotype); contains fumarprotocetraric, protocetraric and homosekikaic acids and the substance Cph-2 (Stenroos, 1988).

**Primary thallus** of small, thick squamules, squamules persistent or evanescent, 1.0-3.0 mm long, 0.5-1.0 mm wide, incised, occasionally sorediate on the margins or densely granular-sorediate. **Podetia** arising from the upper surface of the primary squamules, very variable, cylindrical or tapering towards the apices, 10-30 mm tall (rarely to 50 mm), 0.5-1.5 (2.5) mm diam., axils closed; tips subulate, blunt or provided with shallow, narrow scyphi 1.0-2.0 mm wide, sometimes proliferating from margins; surface of podetia corticate, or corticate at base and lower portion of podetia, cortex continuous or areolate, ecorticate areas often brown, coarsely granular-sorediate, or with corticate granules or squamules, squamules thick, roundish to somewhat elongated, often projecting downwards, easily eroded and exposing the pellucid sterome. **Apothecia** convex, pale brown to mid-brown, 2.0-2.5 mm diam., terminal on podetia or on short, corticate proliferations on the margins of the scyphi; spores eight per ascus, colourless, simple, ellipsoid, 7-10 x 3-4  $\mu\text{m}$ . **Pycnidia** on apices of podetia, on short marginal proliferations of the scyphi or on basal squamules, conidia 5-6 x 1  $\mu\text{m}$ , slightly arcuate.

**Chemistry:** Thallus K-, P+ brick red; containing fumarprotocetraric acid, protocetraric acid (trace), homosekikaic acid, sekikaic acid (trace), 4'-O-methylnorhomosekikaic acid (trace) and  $\pm$  unknowns Cph-1 and Cph-2 (traces).

This species has been synonymized with *Cladonia ramulosa* (With.) Laundon by Stenroos (1988) but *C. adspersa* differs chemically, containing medullary homosekikaic acid in addition to fumarprotocetraric acid. These two species also exhibit quite distinctive geographic distributions — *C. ramulosa* is cosmopolitan but *C. adspersa* is restricted to eastern Asia and Australasia. Furthermore Yoshimura (1967) distinguished *C. adspersa* from *C. ramulosa* by the presence of a pellucid sterome (this being semi-pellucid in *C. ramulosa*).

*C. adspersa* is an Asian-Australasian species growing on moist soil banks, rocks and dead wood in moist, semi-shaded positions. It is widespread in Australia (all States) and also occurs in Malaysia, Indonesia, Papua New Guinea, New Zealand, Solomon Islands and Fiji. Common in Norfolk Island.

**Specimens Examined:**

NORFOLK ISLAND. On soil bank, S9, *JAE 18456*; on *Cyathea* stump, S12, *JAE 18593*,

HS 34369, 34384; on soil of road bank, S24, *JAE 18832*, *HS 34850*; on rocks, S32, *JAE 18740*, *HS 34689*.

*Cladonia bacillaris* Nyl., *Not. Sällsk. Fauna Fl. Fenn. Förh.* 8: 179 (1866).

*Type*: not designated.

**Primary thallus** of small, persistent squamules, 0.5-1.0 mm wide, 0.5-1.5 mm long, margins with or without soredia. **Podetia** growing from the basal squamules, pale green, simple or rarely branched near the apices, escyphose, 0.8-1.5 mm tall, 0.5-1.5 mm diam., ecorticate and completely covered with farinose soredia, rarely with a short, smooth corticate area at the base, with a slight swelling below the apothecium; sterile podetia blunt or rarely subulate, rarely squamulose from the basal corticate areas. **Apothecia** and **pycnidia** not seen in Norfolk Island material. Nowak and Tobolewski (1975) report apothecia that are red, convex, terminal, 0.5-1.0 mm diam.; spores 8 per ascus, colourless, simple, ellipsoid,  $9-11 \times 2-3 \mu\text{m}$ .

**Chemistry**: Thallus K-, KC-, P-; containing barbatic acid (major), 4-*O*-demethylbarbatic acid (trace), unknown (trace). This was the only chemotype observed on Norfolk Island but didymic acid and condidymic acid are common accessory compounds in *C. bacillaris* from other areas.

This species recently was reported to be conspecific with *Cladonia macilenta* Hoffm. (Christensen, 1987), but as the two taxa differ chemically (*C. macilenta* contains thamnolic acid) and in our opinion morphologically (*C. bacillaris* has pale green-grey, somewhat blunt, unbranched podetia while *C. macilenta* brown-white, subulate, sparingly branched podetia) the name *C. bacillaris* is retained here.

*C. bacillaris* is a cosmopolitan species growing on dead wood or on soil. It is widespread in both cool-temperate and tropical regions of the world and relatively common in unpolluted, moist coastal and hinterland habitats. In Australasia it is known from southern and eastern Australia, New Zealand and Papua New Guinea. Rare in Norfolk Island.

**Specimen Examined:**

NORFOLK ISLAND. On soil of semi-shaded roadside, S24, *HS 34849*.

*Cladonia floerkeana* (Fr.) Flörke, *Clad. Comment.*: 99 (1828).

*Cenomyce floerkeana* Fr., *Lich. Suec. Exsicc.*: 82 (1824).

*Type*: (Sweden) not designated.

**Primary thallus** of small, inconspicuous basal squamules, 0.5-1.0 mm wide, 1.0-2.0 mm long. **Podetia** growing from the basal squamules, simple or sparingly branched near the apices, escyphose, sterile podetia subulate, 5-10 mm tall, 0.5-1.0 mm diam., the major part of the podetia and the area below the apothecia corticate, the cortex scabrose to subverrucose, the remainder ecorticate and minutely squamulose or granular-sorediate, or the podetia completely corticate. **Apothecia** common, red, convex, terminal, 1-3 mm diam.; spores eight per ascus, colourless, simple, ellipsoid,  $8-10 \times 2.5-4 \mu\text{m}$ . **Pycnidia** red, minute, urceolate, on apices of podetia, conidia not seen.

**Chemistry**: Thallus K+ yellow or K-, KC-, P+ yellow or P-; containing barbatic acid (major), 4-*O*-demethylbarbatic acid (trace), didymic acid (major), thamnolic acid ( $\pm$  major) and condidymic acid (trace).

*C. floerkeana* is a cosmopolitan species growing on dead or burnt wood or on soil. It is widespread in both cool-temperate and tropical regions of the world and relatively common in unpolluted, moist coastal and hinterland habitats. In Australasia it is known from Australia (all States except W.A., N.T.), New Zealand, Papua New Guinea and New Caledonia. Rare in Norfolk Island.

### **Specimens Examined:**

NORFOLK ISLAND. On old post, S12, *JAE 18555*; Norfolk Island, *J. & T. Gilbert*, s.n. (HO 53167).

*Cladonia fruticulosa* Krempelh., *Verh. zool.-bot. Ges. Wien* 30: 331 (1882) ('1881').

**Type:** Australia. Rockingham Bay [Rockingham Bay], Queensland, *J. Dallachy* s.n. (M — lectotype, MEL, NSW, REN-Abb — isoelectotypes); contains fumarprotocetraric acid (Archer, 1986).

**Primary thallus** of persistent squamules, 1.5-5.0 mm long, 1.0-2.0 mm wide, slightly to deeply lacinate, often incurved, green above, white, cottony to partly granular-sorediate below. **Podetia** arising centrally or more often marginally from the primary squamules, simple or branched by scyphus formation or by podetial squamules which may become elongated and producing new podetia (especially in the apical parts of the podetia), frequently flexuose or somewhat deformed; 10-30 mm tall (rarely to 50 mm), 0.5-1.5 (2.5) mm diam., axils closed; tips blunt or scyphose, scyphi 0.5-4.0 mm wide, shallow, rather abruptly flaring, often slightly deformed; surface of podetia varying from smooth or roughly corticate to partly sorediate, with occasional podetial squamules; soredia granular,  $\pm$  in well-defined soralia, frequently eroded and exposing the semi-pellucid sterome. **Apothecia** pale brown to mid-brown, 1.0-2.0 mm diam., stipitate or marginal on the scyphi or on basal squamules; spores eight per ascus, colourless, simple, ellipsoid,  $7-8 \times 3-4 \mu\text{m}$ . **Pycnidia** dark brown, urceolate, on apices of podetia, marginal on the scyphi or on basal squamules, conidia  $7-8 \times 1 \mu\text{m}$ , slightly arcuate.

**Chemistry:** Thallus K-, P+ red; containing fumarprotocetraric acid (major), protocetraric acid (trace).

This species has been synonymized with *Cladonia subpityrea* Sandst. by Stenroos (1988) but *C. fruticulosa* differs chemically, containing medullary fumarprotocetraric and protocetraric acids rather than the psoromic and 2'-O-demethylpsoromic acids present in *C. subpityrea*. *C. fruticulosa* has been reported to produce smaller, more powdery soredia than does *C. subpityrea* (Stenroos, 1988), but too few specimens were available in the present work to enable valid comparisons.

*C. fruticulosa* is a circum-Pacific species commonly growing on moist soil banks in open areas, but also occurring on rocks, the base of trees and dead wood. It is widespread in Japan, Taiwan, India, Malaysia, Indonesia, Papua New Guinea, eastern Australia (Qld., northern N.S.W.), Solomon Islands, Fiji, Hawaii, the Society Islands and Central America. Uncommon in Norfolk Island.

### **Specimens Examined:**

NORFOLK ISLAND. On moist soil bank, S17, *JAE 18754*, *HS 34696*.

*Cladonia praetermissa* A. W. Archer, *Muelleria* 5: 273 (1984).

**Type:** Australia, New South Wales, Epping, near track by side of Devlin's Creek, 151°05'E, 33°45'S, alt. ca 80 m, 18.vii.1982, *Archer 1376* (MEL 1036220-holotype, H, NSW-isotypes).

**Primary thallus** of conspicuous and persistent squamules, 6-10 mm long, 2-5 mm wide, pale green above, sometimes with soredia fallen from the podetia, white below, the margins crenate or somewhat incised. **Podetia** arising from the basal squamules, simple or rarely branched near the apices, subulate or somewhat cylindrical, 5-15 mm tall (rarely to 20 mm), 0.3-0.7 mm diam., corticate at the base and becoming ecorticate and granular-sorediate at the tip; sometimes squamulose near the base. **Apothecia** rare, pale brown to brown, terminal on the branches, convex, 0.2-0.6 mm diam.; spores eight per ascus, colourless, simple, ellipsoid, 7-10 x 3-4  $\mu\text{m}$ . **Pycnidia** not seen.

**Chemistry:** Thallus K+ pale yellow, KC-, P+ red; containing atranorin (major), fumarprotocetraric acid (major), protocetraric acid (trace).

*C. praetermissa* is a widespread Australasian species growing on sandy soil in moist, semi-shaded positions. It is known from Australia (all States except N.T.) and the North Island of New Zealand. Common in Norfolk Island.

**Specimens Examined:**

NORFOLK ISLAND. On charred stump, S4, *JAE 18206*; on soil bank, S9, *JAE 18453*, *18454*; on soil at edge of large pit, S12, *HS 34234*; on soil over volcanic rocks, S18, *JAE 18763*; on soil, Mt. Pitt Reserve, 167°56'E, 29°04'S, 130 m, *R. Goldsack*, 25.xii.1981 (A. Archer 1226, NSW).

*Cladonia subpityrea* Sandst. in Keissler, *Ann. Naturhist. Mus. Wien* 42: 61 (1928); in Zahlbr., *Krypt. exs. Vindob.* 3056 (1928) (printed label).

**Type:** The Philippines. Luzon. Manila: Dumulmog, alt. c. 1500 m, *Merrill*, *Krypt. exs. Vindob.* 3056 (W — lectotype, H, GB — isolectotypes); contains usnic and psoromic acids (Stenroos, 1988). For further synonymy see Stenroos (1988).

**Primary thallus** of persistent squamules, 1.5-5.0 mm long, 1.0-2.0 mm wide, slightly to deeply lacinate, often incurved, green above, white, cottony to partly granular-sorediate below. **Podetia** arising centrally or more often marginally from the primary squamules, simple or branched by scyphus formation or by podetial squamules which may become elongated and produce new podetia (especially in the apical parts of the podetia), frequently flexuose or somewhat deformed; 10-30 mm tall (rarely to 50 mm), 0.5-1.5 (2.5) mm diam., axils closed; tips blunt or scyphose, scyphi 0.5-4.0 mm wide, shallow, rather abruptly flaring, often slightly deformed; surface of podetia varying from smooth or roughly corticate to partly sorediate, with occasional podetial squamules; soredia granular,  $\pm$  in well defined soralia, frequently eroded and exposing the semi-pellucid sterome. **Apothecia** pale brown to mid-brown, 1.0-2.0 mm diam., stipitate or marginal on the scyphi; spores eight per ascus, colourless, simple, ellipsoid, 7-8 x 3-4  $\mu\text{m}$ . **Pycnidia** dark brown, urceolate, on apices of podetia, marginal on the scyphi or on basal squamules, conidia 7-8 x 1  $\mu\text{m}$ , slightly arcuate.

**Chemistry:** Thallus K-, P+ intense yellow. Containing psoromic acid (major), 2'-O-demethylpsoromic acid (minor) and  $\pm$  usnic acid or isousnic acid (major).

This species has been synonymized with *Cladonia fruticulosa* Krempelh. by Stenroos (1988) but *C. subpityrea* differs chemically, containing medullary psoromic and 2'-O-demethylpsoromic acids rather than the fumarprotocetraric and protocetraric acids

present in *C. fruticulosa*. *C. subpityrea* has been reported to produce larger, less powdery soredia than does *C. fruticulosa* (Stenroos, 1988), but too few specimens were available in the present work to enable valid comparisons.

*C. subpityrea* is an Asian-Australasian species commonly growing on moist soil banks in open areas, but also occurring on rocks, the base of trees and dead wood. It is widespread in Japan, Taiwan, India, Réunion Is., Malaysia, Indonesia, Papua New Guinea, eastern Australia (Qld., northern N.S.W.), Solomon Islands, Fiji, Hawaii and the Society Islands. Uncommon in Norfolk Island.

**Specimens Examined:**

NORFOLK ISLAND. On soil bank, S9, *JAE 18455*; on shaded road cutting, S5, *HS 31964*.

*PERTUSARIA* de Candolle

**Artificial Key to *Pertusaria* in Norfolk Island**

1. Saxicolous, dull or pale yellow, sorediate, lacking verrucae and spores ..... *P. persulphurata*
1. Corticolous, variously coloured, with or without fertile verrucae, soredia present or absent ..... 2
2. Thallus lacking verrucae, isidiate or sorediate ..... 3
2. Thallus with verrucae, lacking isidia and soredia ..... 4
3. Thallus sorediate, pale greenish-grey, with scattered soralia; KC+ violet, picrolichenic acid present ..... *P. verdonii*
3. Thallus isidiate, pale olive-green; KC-, stictic acid present ..... *P. montpittensis*
4. Thallus yellow, 2 spores per ascus, thiophaninic acid present ..... *P. thiospoda*
4. Thallus pale green, off-white or pale grey, 4 or 8 spores per ascus, thiophaninic acid absent ..... 5
5. Spores 4 per ascus, thallus pale grey ..... *P. nebulosa*
5. Spores 8 per ascus; thallus pale green to off-white ..... 6
6. Thallus off-white, K+ red, norstictic acid present; spores ellipsoid, 45-55 x 16-20  $\mu\text{m}$  ..... *P. norfolkensis*
6. Thallus pale green, K-, stictic acid present; spores fusiform, 100-140 x 35-50  $\mu\text{m}$  ..... *P. dehiscens*

*Pertusaria dehiscens* Müll. Arg., *Flora*, Regensburg 67: 286 (1884).

**Type:** Brazil, Apiahy [Apiai, c. 250 km SW of Sao Paulo], July 1882, *Puiggari 499* (G-lectotype).

**Thallus** pale to dark olive-green, wrinkled and cracked, lacking isidia and soredia, surface dull, corticolous. **Apothecia** verruciform, conspicuous, numerous, concolorous with the thallus, flattened-hemispherical, 0.8-1.5 mm diam., often constricted at the base; ostioles uncommon, black, punctiform, 2-5 per verruca in a hyaline zone, the zone becoming conspicuous, deeply concave and almost disciform, to 0.8 mm diam.; **spores** eight per ascus, biseriate, smooth, fusiform, 100-140 (-150) x 35-50  $\mu\text{m}$ .

**Chemistry:** K-, KC-, C-, Pd-; containing lichexanthone, stictic acid and norstictic acid (trace).

*P. dehiscens* is characterized by the eight-spored asci with biseriate fusiform spores,

and the presence of lichexanthone and stictic acid. *P. dehiscens* resembles the New Zealand endemic *P. theochroa* Krempelh. (Galloway, 1985) which also has eight biseriata spores, but is distinguished from that species by the chemistry, and the appearance of the ostioles. *P. theochroa* contains 4,5-dichlorolichexanthone and 2'-*O*-methylperlatolic acid and has inconspicuous, minute black ostioles which lack the outer hyaline zone present in *P. dehiscens*. *P. dehiscens* also occurs in Australia (Qld., N.S.W.) and Brazil. Uncommon in Norfolk Island.

***Specimens Examined:***

NORFOLK ISLAND. On palm, S14, JAE 18682; on *Citrus limon*, S24, JAE 18809.

***Pertusaria montpittensis* A. W. Archer sp. nov. (Fig. 2A)**

Thallus corticola, olivaceus vel stramineus, tenuis, continuous, superficies laevis et nitida, sorediis destitutus, copiose isidiata praeter marginem; isidia thallo concoloria, subclaviformia, simplicia vel ramosa et demum coralliformia fiunt, 0.4-1 mm alta, 0.2-0.5 mm diam.; apothecia ignota. Thallus 4,5-dichlorolichexanthone et acidum sticticum continens.

**Type:** Norfolk Island. On *Elaeodendron* in mixed sub-tropical rainforest, Mt Bates summit trail, Mt Pitt Reserve, 29°00'S, 167°56'30"E, 300 m, J. A. Elix 18641 and H. Streimann, 7.xii.1984 (CBG-holotype).

**Thallus** pale olive-green to pale yellow-grey, thin, continuous, surface smooth and shiny, copiously isidiate away from the margin, corticolous; **isidia** concolorous with the thallus, simple, branched or becoming coralloid, narrow at the base and swelling somewhat at the tip, 0.4-1.0 mm tall, 0.2-0.5 mm diam.; verrucae, ostioles, apothecia, asci and spores not seen.

**Chemistry:** K-, KC-, C-, Pd-; containing 4,5-dichlorolichexanthone and stictic acid.

*P. montpittensis* is distinguished from other sterile, isidiate, corticolous Australian species of *Pertusaria* by its chemistry. The medullary constituents also distinguish this new species from the corticolous, isidiate Hawaiian species, *P. ramulifera* Magn. (Magnusson & Zahlbruckner, 1944), which contains norstictic acid. *P. montpittensis* grows on *Araucaria*, *Elaeodendron*, *Callistemon* and mangroves, and is so far known only from Norfolk Island and two locations in eastern Queensland. Riedl (1988) described in detail an unnamed sterile *Pertusaria* from Norfolk Island that corresponds to *P. montpittensis* but the chemistry of his specimen was not reported. Common in Norfolk Island.

***Specimens Examined:***

NORFOLK ISLAND. On trunk of *Araucaria heterophylla*, S1, JAE 18158; on tree trunk, S5, JAE 18292, 18313, 18346, 18348; on *Elaeodendron*, S7, JAE 18336; on *Elaeodendron*, S12, JAE 18630 (topotype); on trunk of *Araucaria heterophylla*, S19, JAE 18780.

AUSTRALIA. Queensland, Ingham-Kangaroo Hills road, Seaview Range, 30 km south-west of Ingham, J. A. Elix 20413, 19.vi.1986 (ANUC); Springbrook, near N.S.W./Queensland border, H. Lumbsch 5391h, 11.vii.1987 (herb. LUMBSCH).

***Pertusaria nebulosa* A. W. Archer sp. nov. (Fig. 2B)**

Thallus subolivaceus, parum tuberculatus, corticola, superficies laevis et nitida, isidiis et sorediis destitutus; apothecia numerosa, verruciformia, conspicua, complanata hemisphaerica, basibus constrictis, raro confluentia, 0.8-1.5 mm diam.; ostiola conspicua, nigra, in verrucas 1-4nae; sporae 4nae, uniseriatae, ellipsoideae, laeves, 95-115 x 30-35  $\mu$ m. Thallus vestigia substantiarum incognitarum continens.

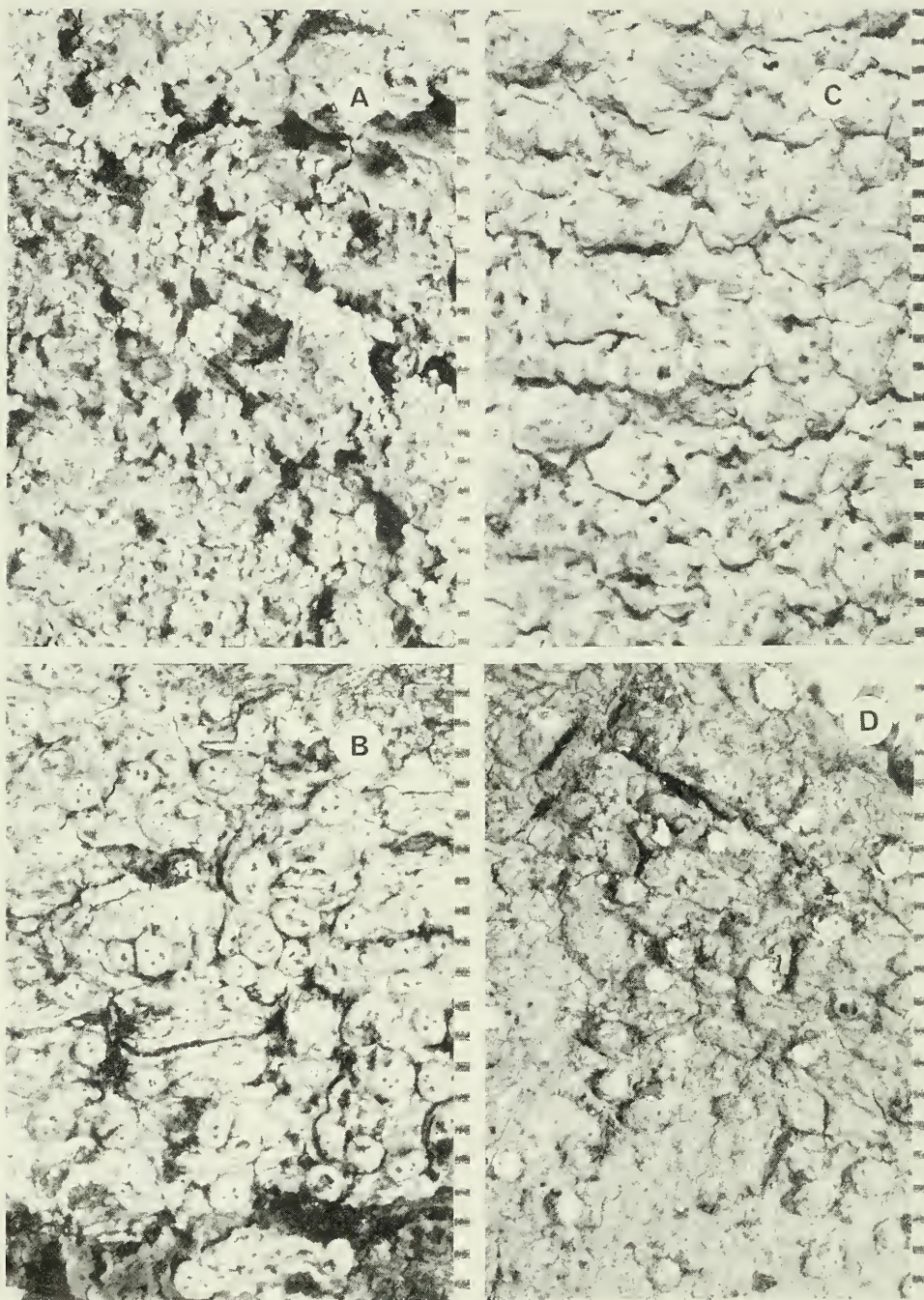


Fig. 2. Lichen types: A, holotype of *Pertusaria montpittensis*; B, holotype of *Pertusaria nebulosa*; C, holotype of *Pertusaria norfolkensis*; D, holotype of *Pertusaria verdonii*. Scales in millimetres.

**Type:** Norfolk Island. On *Elaeodendron* in regrowth forest, just south of the Captain Cook Memorial, Duncombe Bay, 29°00'20"S.; 167°57'30"E, 100 m, *J. A. Elix 18389* and *H. Streimann*, 3.xii.1984 (CBG-holotype).

**Thallus** pale olive-green, slightly tuberculate, surface smooth and shiny, lacking isidia and soredia, corticolous. **Apothecia** verruciform, conspicuous, numerous, rarely confluent, flattened hemispherical, becoming constricted at the base, 0.8-1.5(-2.0) mm diam.; ostioles conspicuous, black, lacking a hyaline margin, 1-4 per verruca; **spores** 4 per ascus, uniseriate, ellipsoid, smooth, 95-115 x 30-35  $\mu$ m.

**Chemistry:** K-, KC-, C-, Pd-; unidentified traces only found by thin layer chromatography.

This new species superficially resembles *P. javanica* Müll. Arg. (Müller Arg., 1884) as both taxa have numerous, conspicuous black ostioles on each verruca. However, *P. javanica* has spores which are rough and larger, 87-137(-165) x 40-47  $\mu$ m, and contains stictic acid. This species is known only from the type specimen and apparently is rare in Norfolk Island.

***Pertusaria norfolkensis*** A. W. Archer sp. nov. (Fig. 2C)

Thallus albidus vel flavido-albus, areolatus et rimosus, asper et tuberculatus, corticola, isidiis et sorediis destitutus; apothecia verruciformia, inconspicua, thallo concoloria, irregulariter hemisphaerica, basibus non constrictis, interdum confluentia, 1-2 mm diam.; ostiola conspicua, nigra, depressa, in verrucas 1-4na; sporae 8nae, biseriatae, ellipsoideae, laeves, 45-55  $\mu$ m longae, 16-20  $\mu$ m latae. Thallus acidum norsticticum continens.

**Type:** Norfolk Island. On treelet stem in poor forest on gentle slope, Mt Pitt, Mt Pitt Reserve, 29°01'S, 167°56"E, 300 m, *H. Streimann 34845*, 10.xii.1984 (CBG-holotype; B-isotype).

**Thallus** off-white to pale yellowish-white, areolate and cracked, rough and tuberculate, surface dull, lacking isidia and soredia, corticolous. **Apothecia** verruciform, inconspicuous, concolorous with the thallus, irregularly hemispherical, not constricted at the base, sometimes confluent, 1-2 mm diam.; ostioles conspicuous, black, sunken, 1-4 per verruca; **spores** 8 per ascus, biseriatae, ellipsoid, smooth, 45-55 x 16-20  $\mu$ m.

**Chemistry:** K+ red, C-, Pd+ orange; containing norstictic acid.

*P. norfolkensis* is distinguished from other corticolous Australian *Pertusaria* containing norstictic acid by its eight small biseriatae spores. It resembles the corticolous South American species *P. syngenetica* Müll. Arg. (Müller Arg., 1884), which also has eight biseriatae spores (45-52 x 20-25  $\mu$ m), but lacks norstictic acid. The new species is known only from the type specimen and apparently is rare in Norfolk Island.

***Pertusaria persulphurata*** Müll. Arg., *Nuovo Giorn. Bot. Ital.* 23: 391 (1891).

**Type:** Australia [Queensland], Brisbane, *Bailey s.n.* (G-holotype).

**Thallus** variable, usually thin, rarely thick, pale, bright or dull yellow, areolate and cracked, surface smooth and dull, sorediate, saxicolous; soralia sparse to numerous, scattered, 0.3-0.5 mm diam.; verrucae, asci and spores absent.

**Chemistry:** K-, KC+ orange-red, C+ orange, P-; containing thiophaninic acid, lichexanthone ( $\pm$ ), stictic acid ( $\pm$ ). The chemistry of *P. persulphurata* (as *P. sulphurata*) has been reported in detail (Elix *et al.*, 1978).

*P. persulphurata* also occurs in eastern Queensland and New South Wales where it is common on exposed sandstone. Specimens from mainland Australia are usually bright yellow whereas the Norfolk Island specimens are a dull yellow-brown (JAE 18186, 18494) or a pale yellowish brown (JAE 18479, 18505); all four specimens contain lichexanthone plus thiophaninic and stictic acids, and the slight differences in colour may be due to the different substrate (volcanic rock). Common in Phillip Island but scattered in Norfolk Island.

**Specimens Examined:**

NORFOLK ISLAND. On volcanic rocks, S2, JAE 18186; on volcanic rocks, S10, JAE 18479, 18494, 18505.

*Pertusaria thiospoda* Knight, *Trans. Linn. Soc. London, Bot.* 2: 47 (1882).

**Type:** Australia, New South Wales [neighbourhood of Sydney, *vide* Filson 1986], Knight 20 (WELT-holotype).

**Thallus** pale yellowish white to pale yellow, thin, margin effuse, slightly cracked, surface smooth and dull, lacking isidia and soredia, corticolous. **Apothecia** verruciform, inconspicuous, scattered to crowded, sometimes confluent, not constricted at the base, concolorous with the thallus, 0.5-1.0 mm diam.; ostioles pale brown to black, 1 per verruca; spores 2 per ascus, uniseriate, ellipsoid, smooth, 80-100(-120)  $\times$  30-40  $\mu$ m.

**Chemistry:** K-, KC+ yellow-orange, C+ yellow-orange, Pd-; containing thiophaninic and stictic acids.

*P. thiospoda* is a common corticolous Australasian *Pertusaria* found in Queensland, New South Wales, Tasmania and Lord Howe Island. It is characterized by the pale yellow thallus, the two ellipsoid spores and the presence of thiophaninic and stictic acids. Uncommon in Norfolk Island.

**Specimens Examined:**

NORFOLK ISLAND. On *Melia*, S4, JAE 18318; sine loco, J. H. Maiden and J. L. Boorman s.n., xi. 1902 (NSW L4431).

***Pertusaria verdonii* Archer sp. nov. (Fig. 2D)**

Thallus olivaceus, rugosus et rimosus, corticola, superficies laevis et hebetata, isidiis destitutus, sorediata; soralia conspicua, dispersa, thallo concoloria, subhemisphaerica, 1.0-1.5 mm diam.; apothecia ignota. Thallus lichexanthone continens.

**Type:** Norfolk Island. On *Elaeodendron* in mixed subtropical rainforest, near Broken Pine, Mt Pitt Reserve, 29°01'30"S, 167°56'20"E, 240 m, J. A. Elix 18283 and H. Streimann, 2.xii.1984 (CBG-holotype).

**Thallus** olive-green, wrinkled and cracked, surface smooth and dull, lacking isidia, sorediate, corticolous; **soralia** conspicuous, scattered, hemispherical, concolorous with the thallus, 1.0-1.5 mm diam.; verrucae, asci and spores absent.

**Chemistry:** K-, KC+ violet, C-, Pd-; lichexanthone, picrolichenic acid and a picrolichenic acid homologue.

This new species is distinguished from other sterile Australian, corticolous,

sorediate species of *Pertusaria* by its chemistry. Similarly it differs from the common Northern Hemisphere species, *P. amara* (Ach.) Nyl. by the presence of lichexanthone and the absence of protocetraric acid. This species is known only from the type specimen and apparently is rare on Norfolk Island. It is named in honour of the Australian lichenologist Mr Douglas Verdon.

### *PSEUDOCYPHELLARIA* Vainio

#### Artificial Key to *Pseudocyphellaria* in Norfolk Island

- |   |                        |
|---|------------------------|
| 1. Photobiont blue-green .....                        | 2                      |
| 1. Photobiont green .....                             | 3                      |
| 2. Pseudocyphellae yellow .....                       | <i>P. crocata</i>      |
| 2. Pseudocyphellae white .....                        | <i>P. haywardiorum</i> |
| 3. Isidia granular-coralloid, eroding, yellow .....   | <i>P. poculifera</i>   |
| 3. Isidia squamiform, corticate, green to brown ..... | <i>P. pickeringii</i>  |

*Pseudocyphellaria crocata* (L.) Vainio, *Hedwigia* 37: 34 (1898).

*Lichen crocatus* L., *Mantissa Pl.*: 310 (1771).

**Type:** India, sine loco, *König* (LINN 1273. 137-holotype).

For further synonymy see Galloway (1988).

**Thallus** corticolous, muscicolous or saxicolous, loosely adnate, undulate at the margins, grey-blue when moist, yellow-brown to dark red-brown when dry, forming rosettes or irregularly spreading, 5-20 cm in diam. **Lobes** irregular, 5-15 mm wide,  $\pm$  rotund at the apices to deeply lacinate, discrete at margins to imbricate centrally, margins sinuous,  $\pm$  subascending to ragged, incised, sorediate. **Upper surface** shallowly and irregularly wrinkled to densely faveolate, ridged or pitted, dull to shiny, maculate, maculae more obvious in faveolate specimens, white, distinctly reticulate, following ridges and in faveolae, lacking isidia, phyllidia and pseudocyphellae, sorediate; **soredia** yellow, marginal and laminal, variable, in scattered erose soralia to linear-elongate marginal soralia with densely farinose yellow soredia, or erupting from pseudoisidiate warts on margins and laminal ridges where the central parts erode and form yellow granular soredia; medulla white. **Photobiont** blue-green (*Nostoc*). **Lower surface** pale yellow at margins to dark brown-black centrally, tomentose, tomentum short, variable, buff to dark red-brown or black. **Pseudocyphellae** yellow, occasional to numerous, punctiform at margins, sunk into the tomentum or  $\pm$  projecting above, 0.1-1.2 mm diam. **Apothecia** rare, marginal or laminal, solitary or grouped, subpedicellate, concave, 0.5-3.0 mm diam., disc red-brown, margin pale pink, often overlapping disc at first, ultimately dentate-irregular, amphithecium verrucose-areolate,  $\pm$  tomentose towards base; spores olive-brown to dark brown, 1-3 septate, broad-ellipsoid, straight or slightly curved,  $22-28 \times 8-9 \mu\text{m}$ . **Pycnidia** not seen.

**Chemistry:** K+ yellow, C-, P+ orange; containing pulvinic acid, pulvinic dilactone, 6 $\alpha$ -acetoxyhopane-7 $\beta$ ,22-diol (trace), 7 $\beta$ -acetoxyhopane-6 $\alpha$ ,22-diol (trace), hopane-7 $\beta$ ,22-diol (trace), hopane-6 $\alpha$ ,7 $\beta$ ,22-triol, tenuiorin, methyl gyrophorate, gyrophoric acid (trace), physciosporin ( $\pm$  trace), norstictic acid (trace), stictic acid, cryptostictic acid (trace), constictic acid (trace), salazinic acid ( $\pm$ ).

*P. crocata* is a cosmopolitan species widely distributed in both hemispheres. In Australasia it is known from Australia, New Zealand, Papua New Guinea and Fiji. Uncommon in Norfolk Island.

**Specimens Examined:**

NORFOLK ISLAND. On mossy rocks, S32, JAE 18732, JAE 18734 (*Lich. Australasici Exsicc.* Fasc. 4: 92); on tree trunk, S32, HS 34633 (B, H, US).

*Pseudocyphellaria haywardiorum* D. Galloway, *Bull. Br. Mus. nat. Hist. (Bot.)* 17: 159 (1988).

**Type:** New Zealand. North Island, South Auckland, Red Mercury Island, on tea tree (*Leptospermum*) bark, August 1971, B. W. & G. C. Hayward H 40.4 (AK 161261-holotype).

**Thallus** corticolous, loosely adnate to adnate,  $\pm$  ascending at the margins, dark grey-blue to blue-black when moist, olive-brown to yellow-grey when dry,  $\pm$  orbicular, 3-7 cm in diam. **Lobes** irregular, 2-10 mm wide, discrete, deeply lacinate, barely imbricate, margins sinuous,  $\pm$  ascending, irregular, crenate-lacerate, sorediate. **Upper surface** plane or shallowly undulate,  $\pm$  wrinkled-faveolate at the apices, elsewhere punctate-impressed, maculate, maculae minute, whitish, more obvious in reticulate pattern towards the apices, lacking isidia, phyllidia and pseudocyphellae, sorediate; **soredia** dark blue-grey, coarsely granular to pseudoisidiate, marginal and laminal, variable, in scattered round to irregular laminal soralia to linear-elongate soralia at the margins or coalescing and forming broad areas of sorediate to pseudoisidiate crust; medulla white. **Photobiont** blue-green (*Nostoc*). **Lower surface** pale buff at margins, densely tomentose, tomentum buff to red-brown or dark brown centrally. **Pseudocyphellae** white, conspicuous, well delimited from the tomentum, rare at margins, common centrally, 0.1-2.0 mm diam. **Apothecia** not seen in Norfolk Island specimens. According to Galloway (1985), apothecia rare, marginal or laminal, solitary or grouped, sessile to subpedicellate, concave at first to convex at maturity, 0.5-2.5 mm in diam., disc yellow to dark red-brown, margin pale buff to brownish, amphithecium scabrid-verrucose; spores yellow-brown, 1-septate, fusiform-ellipsoid, apices pointed, 30-32 x 6-7  $\mu$ m. **Pycnidia** not seen.

**Chemistry:** K-, C-, KC-, P-; containing 7 $\beta$ -acetoxyhopane-22-ol, hopane-15 $\alpha$ ,22-diol, hopane-7 $\beta$ ,22-diol (trace).

*P. haywardiorum* is a relatively rare Australasian species known also from the north of the North Island of New Zealand. Uncommon in Norfolk Island.

**Specimens Examined:**

NORFOLK ISLAND. On base of *Araucaria heterophylla* and treefern stem, S12, JAE 18594, 18598, HS 34386 (H).

*Pseudocyphellaria pickeringii* (Tuck.) D. Galloway, *Bull. Br. Mus. nat. Hist. (Bot.)* 17: 218 (1988).

*Sticta pickeringii* Tuck., *U.S. Exploring Exped.* 17 (Bot.): 1138 (pl. 1, fig. VI, 1 & 2) (1874).

**Type:** New Zealand. Bay of Islands, Wilkes Exped., sine collectoribus nomine (FH-holotype).

**Thallus** corticolous or saxicolous, tightly to loosely adnate centrally, thin and brittle to  $\pm$  coriaceous, bright emerald-green to glaucous-green when moist, pale yellow-green to yellow-brown when dry, 5-10(-20) cm diam. **Lobes** irregular, 5-15 mm wide,  $\pm$  rotund at the apices, rarely entire, usually notched and incised, rather ragged, imbricate or subascending at the margins. **Upper surface** shallowly wrinkled or pitted, dull, emaculate, continuous, smooth or minutely scabrid in parts, isidiate-phyllidiate; **isidia** mainly marginal but also spreading laminally, simple and terete at first but becoming coralloid, flattened, squamiform or phyllidiate, occasionally forming a dense crust obscuring the

thallus; medulla yellow. *Photobiont* green. *Lower surface* pale yellow to brown centrally, tomentose, tomentum rather short, velvety, buff to red-brown. *Pseudocyphellae* yellow, flat to papillate, scattered, fleck-like, 0.05-0.50 mm diam., often obscured, sunk into the tomentum. *Apothecia* very rare, adnate, concave at first but becoming undulate-distorted, to 5 mm diam., disc red-brown, margin involute then excluded at maturity, amphithecium roughened to coarsely verrucose-areolate; spores 1-3(5) septate, fusiform-ellipsoid, apices pointed, 25-30 x 6.5-7.0  $\mu\text{m}$ . *Pycnidia* scattered, laminal, minute, ca. 0.1 mm diam., ostiole red-brown to black.

**Chemistry:** K-, C-, KC-, P-, containing pulvic dilactone, calycin, 2 $\alpha$ ,3 $\beta$ ,22 $\alpha$ -triacetoxystictane, 2 $\alpha$ ,3 $\beta$ -diacetoxystictane-22 $\alpha$ -ol, 2 $\alpha$ -acetoxystictane-3 $\beta$ ,22 $\alpha$ -diol, 3 $\beta$ -acetoxystictane-2 $\alpha$ ,22 $\alpha$ -diol, stictane-3 $\beta$ ,22 $\alpha$ -diol, stictane-2 $\alpha$ ,3 $\beta$ ,22 $\alpha$ -triol, 3 $\beta$ ,22 $\alpha$ -diacetoxystictane, 3 $\beta$ -acetoxystictane-22 $\alpha$ -ol, pseudocyphellarin A, isopseudocyphellarin A, nephroarctin, phenarctin, 2'-O-methylphenarctin, 1'-chloronephroarctin, 2'-O-methylisopseudocyphellarin A, 2'-O-methylpseudocyphellarin A.

*P. pickeringii* is particularly common and widespread in New Zealand (from the Three Kings Islands to Stewart Island) and also known from the Chatham Islands and Fiji. Common in Norfolk Island.

#### *Specimens Examined:*

NORFOLK ISLAND. On sapling, S5, JAE 18289, 18295, 18297; on *Elaeodendron*, S7, JAE 18370; on mossy trunk, S24, JAE 18819; on *Elaeodendron*, S8, HS 32197.

*Pseudocyphellaria poculifera* (Müll. Arg.) D. Galloway & P. James, *Lichenologist* 12: 301 (1980).

*Sticta poculifera* Müll. Arg, *Flora*, Regensburg 65: 304 (1882).

**Type:** Lord Howe Island, Mt Gower, *F. v. Mueller* (G 002123-holotype; BM, MEL-isotypes).

**Thallus** corticolous or rarely saxicolous, loosely adnate, undulate at the margins, more tightly adnate in the centre, bright lettuce-green to glaucous-green when moist, pale yellow-grey to yellow-brown when dry but becoming reddish on storage, forming rosettes or irregularly spreading, 4-10 cm in diam. **Lobes** irregular, 4-10 mm wide, discrete at margins, irregularly laciniate, contiguous centrally but rarely imbricate; margins subascending, undulate, sinuous, often torn and ragged,  $\pm$  coralloid-isidiate or white-tomentose. **Upper surface** shallowly ridged or pitted dull, minutely white-tomentose in parts, isidiate; **isidia** yellow, mainly marginal, rarely spreading to laminal cracks, clustered, minutely coralloid, in part corticate but soon eroding and appearing sorediate; medulla yellow. *Photobiont* green. *Lower surface* pale yellow or buff to brown centrally, irregularly tomentose, tomentum thin and variable, white to buff, elsewhere entirely glabrous, coarsely to finely wrinkled. *Pseudocyphellae* yellow, numerous, conspicuous, punctiform at margins, often confluent centrally, 0.5-1.5 mm diam. *Apothecia* moderately common, submarginal, most common at lobe apices, pedicellate, concave, 2-6 mm diam., disc red-brown, margin ragged, granular-isidiate, often eroding and appearing yellow-sorediate, often overlapping disc, amphithecium minutely white-tomentose at first then areolate-scabrid; spores pale to dark red-brown, 3-septate at maturity, fusiform-ellipsoid, apices pointed, 20-23 x 5.5-7.5  $\mu\text{m}$ . *Pycnidia* common on lower surface, hemispherical, 0.2-0.5 mm diam., ostiole black.

**Chemistry:** K-, C-, KC-, P-; containing pulvinic acid, pulvinic dilactone, calycin, 3 $\beta$ -

acetoxyfern-9(11)-en-12-one, fern-9(11)en-3 $\beta$ ,12 $\beta$ -ol, 3 $\beta$ -hydroxyfern-9(11)-en-12-one, 3 $\beta$ -acetoxyfern-9(11)-en-12 $\beta$ -ol, 3 $\beta$ -acetoxyfern-9(11)-en-19 $\beta$ -ol, unknown triterpenes.

*P. poculifera* is an Australasian species known from Australia (Qld.), New Zealand, New Caledonia, Fiji and Lord Howe Island. Common in Norfolk Island. Several previous reports of *Pseudocyphellaria aurata* (Sm.) Vainio from Norfolk Island (Elix, 1985; Riedl, 1988) refer in fact to *P. poculifera*.

### *Specimens Examined:*

NORFOLK ISLAND. On *Cyathea* trunk, S5, JAE 18315 (*Lich. Australasici Exsicc.* Fasc. 4: 91), on vine, HS 31943 (H, US); on *Elaeodendron*, S7, JAE 18364, HS 32045 (H, US); on mossy trunk, S8, JAE 18407, HS 32159 (H, US); on *Campsis grandiflora*, S9, JAE 18457; on *Citrus limon*, S12, JAE 18571, 18576, 18577, HS 34300 (H); on mossy trunk, S24, JAE 18820, 18823; on shaded rock, S32, HS 34648 (H).

### RAMALINA Acharius

#### Artificial Key to *Ramalina* in Norfolk Island

- |  |                     |
|--|---------------------|
| 1. Thallus sorediate .....   | 2                   |
| 1. Thallus lacking soredia .....   | 3                   |
| 2. Branching intricate, medulla K-, sekikaic acid present .....                | <i>R. peruviana</i> |
| 2. Branching dichotomous, medulla K+ red, salazinic acid present ....          | <i>R. pacifica</i>  |
| 3. Thallus caespitose, less than 4 cm high .....                               | 4                   |
| 3. Thallus subpendulous, more than 4 cm long .....                             | 5                   |
| 4. Thallus usually more than 2 cm high, divaricatic acid present .....         | <i>R. stevensii</i> |
| 4. Thallus less than 1.5 cm high, divaricatic acid absent .....                | <i>R. exiguella</i> |
| 5. Branches broad, 2-4 mm wide, medulla K-, boninic acid present .....         | <i>R. leoidea</i>   |
| 5. Branches narrow, 1-2 mm wide, medulla K+ red, norstictic acid present ..... | <i>R. arabum</i>    |

*Ramalina arabum* (Dill. ex Ach.) Meyen ex Flotow, *Nova Acta Akad. Leopold. Carolin.* 19 Suppl.: 212 (1843).

*Alectoria arabum* Dill. ex Ach., *Lich. Univ.*: 596 (1810).

*Type:* India (not designated).

**Thallus** fruticose, corticolous or saxicolous, erect to pendulous, yellow-green to grey-green, 3-10(-20) cm long; branching predominantly dichotomous, sparse to moderate, branch width (0.5-)1.0-2.0 mm, branches rigid, angular-terete to slightly flattened, lateral branches narrower, irregularly divided, apices finely flexed or bent; cortex matt, smooth, with linear *pseudocyphellae*, occasionally white-striate or longitudinally striate-nervose; holdfast delimited; lacking soredia. **Apothecia** common, lateral to subterminal; disc 1.0-1.5 mm diam., concave to plane; margin thin, entire; spores eight per ascus, colourless, 1-septate, oblong, 12-15(-16) x 5-8  $\mu$ m.

**Chemistry:** Thallus K+ yellow-red, P+ orange; containing usnic acid, norstictic acid (major), connorstictic acid (minor).

*R. arabum* is a pantropical-subtropical maritime species, widely distributed among islands of the Mediterranean Sea, and the Indian, South Atlantic and Pacific Oceans. In Australasia it occurs in northern New Zealand and New Caledonia. Very common in Norfolk Island.

**Specimens Examined:**

NORFOLK ISLAND. On base of *Araucaria heterophylla*, S1, JAE 18132, 18146, 18147, 18159, 18165, 18166 (*Lich. Australasici Exsicc.* Fasc. 4: 95); on volcanic rocks, S2, JAE 18185; on exposed *Araucaria* roots and rocks, S3, HS 31757 (B, H, NY), 31763, 31764; on *Quercus suber*, S4, JAE 18194, on trunk of *Araucaria heterophylla*, S4, JAE 18209; on base of *Araucaria heterophylla*, S6, JAE 18357, HS 32020 (B, H), on dead olive branch, HS 32038 (B, H, US, NY); on branches of *Araucaria heterophylla*, S11, JAE 18508; on old fence posts, S15, JAE 18709; on branches of *Araucaria heterophylla*, S16, JAE 18721 (*Lich. Australasici Exsicc.* Fasc. 4: 96); on volcanic rocks, S17, JAE 18743; on volcanic rocks, S18, JAE 18783; on tree trunk, S25, HS 34879 (B, LSU); on *Araucaria heterophylla*, S27, HS 32248; on truck of *Araucaria heterophylla*, S31, JAE 18714.

*Ramalina exiguella* Stirton, *Trans. Proc. R. Soc. Vict.* 17: 68 (1881).

**Type:** Australia. Queensland, Brisbane, *Bailey* 91 (BRI-holotype; BM-isotype); contains usnic acid (Stevens, 1987).

For further synonymy see Stevens (Stevens, 1987).

**Thallus** fruticose, corticolous, caespitose, erect, rigid, grey-green, to 2 cm high; branching mainly from the base, squarrose branchlets sometimes present on main branches; branch width 0.3-1.0 mm, branches subterete, narrow, apices attenuate, sometimes black-tipped; cortex shiny, longitudinally grooved giving a striate appearance; holdfast delimited; *pseudocyphellae* linear; lacking soredia. *Apothecia* common, usually marginal along the branches and/or subterminal causing the apex of the branch to become geniculate with a long, attenuate spur; disc 0.2-2.0 mm diam., concave, plane to convex; margin entire, thick on immature apothecia; spores eight per ascus, colourless, 1-septate, ovoid to ellipsoid or gibbous and slightly curved, (12-)14-16 x (5-)6-8  $\mu\text{m}$ .

**Chemistry:** Thallus K-, KC-, P-; containing usnic acid.

*R. exiguella* is a coastal species, widely distributed in warm temperate to tropical coastal areas of east Africa, eastern Australia (Qld., N.S.W.) and New Zealand. Rare in Norfolk Island.

**Specimens Examined:**

NORFOLK ISLAND. On dead shrub twigs, S21, HS 34794 (B, H, LSU).

*Ramalina leiodea* (Nyl.) Nyl., *Lich. Nov. Zel.*: 22 (1888).

*Ramalina subfraxinea* ssp. *leiodea* Nyl., *Bull. Soc. linn. Normandie II*, 4: 141 (1870).

**Type:** New Caledonia, 'Donné par le Musée Colonial', 1861, *Deplanche* s.n. (PC-lectotype); contains boninic acid aggregate (Stevens, 1987).

*Ramalina boninensis* Asahina, *J. Jap. Bot.* 14: 253 (1938).

**Type:** Bonin Islands, Ogasawara Island, Hahajima, 1836, *Kusaka* s.n. (TNS-lectotype); contains boninic acid aggregate (Stevens, 1987).

**Thallus** fruticose, corticolous or rarely saxicolous, caespitose, erect to subpendulous, rigid, grey-green, from 4-9 cm high; branching subdichotomous, sparse to moderate; branch width (0.5-)2.0-4.0 mm, branches compressed, flat or canaliculate when narrow, apices attenuate; cortex matt, smooth to rugose, lacking soredia, short linear *pseudocyphellae* sometimes present; holdfast delimited. *Apothecia* common, marginal to subterminal, rarely laminal, small thalli producing subterminal apothecia subtended by a spur; disc 2.0-3.0 mm diam., concave to plane; margin entire or incised at maturity;

spores eight per ascus, colourless, 1-septate, ellipsoid, straight or slightly curved, 10-12(-16)  $\times$  4-5  $\mu$ m.

**Chemistry:** Thallus K-, KC-, P-; containing usnic acid, boninic acid (major), 2-*O*-methylsekikaic acid (minor), 2,4'-di-*O*-methylnorsekikaic acid (minor), 4'-*O*-methylpaludodic acid (minor), 4,4'-di-*O*-methylcryptochlorophaeic acid (minor).

*R. leiodea* is a maritime species, widely distributed among the tropical and subtropical islands of the Pacific (Bonin, Marianas, Lord Howe, New Caledonia, Raratonga, Vanuatu, Hawaii) and Indian Oceans (Mauritius, Réunion), and in eastern Australia (Qld., N.S.W.). Common in Norfolk Island.

**Specimens Examined:**

NORFOLK ISLAND. On base of *Araucaria heterophylla*, S1, JAE 18142, 18145, HS 31711, 31737, 31738; on *Melia*, S4, JAE 18199, 18247, 18248, 18249, HS 31850; on shaded rock, S7, HS 32004 (B); on shaded rock, S18, HS 34744; on twigs of *Eucalyptus*, S28, JAE 18527 (*Lich. Australasici Exsicc.* Fasc. 4: 97).

*Ramalina pacifica* Asahina, *J. Jap. Bot.* 15: 213 (1939).

**Type:** Micronesia. Marianas, Saipan Island, 1925, Kimura s.n. (TNS-lectotype); contains salazinic acid, usnic acid (Stevens, 1987).

*Ramalina insularum* H. Magn., *Ark. Bot.* 3: 361 (1956).

**Type:** Fiji Islands, 1862, Daemel s.n. (H-lectotype); contains salazinic acid, usnic acid (Stevens, 1987).

**Thallus** fruticose, corticolous or rarely saxicolous, tufted, pendulous to subpendulous, pale yellow-green to grey-green, 2-6(-12) cm long; branching dichotomous, sparse to moderately dense but very variable; branch width (0.5-)1.0-5.0 mm, branches flat, compressed, sometimes splitting along the margins; broad in the basal region but gradually narrowing towards the apices or narrow in the basal region and continuing uniformly to the apices; apices attenuate, mostly forked; cortex matt or shiny, smooth or with linear *pseudocyphellae* slightly or strongly developed, sorediate; holdfast delimited and rounded; *soralia* marginal or laminal, round to ellipsoid, often coalescing, the edges revolute. **Apothecia** rare, marginal, disc 1.0-3.0 mm diam., concave, plane to convex, margin often incised at maturity; spores eight per ascus, colourless, 1-septate, fusiform to ellipsoid, straight or slightly curved, 12-16(-20)  $\times$  4-7  $\mu$ m.

**Chemistry:** Thallus K+ yellow-red, P+ orange; containing salazinic acid (major), protocetraric acid (trace) and usnic acid (minor/trace).

*P. pacifica* is widely distributed in warm temperate to subtropical regions surrounding the Indian and eastern Pacific Oceans, including South Africa, Burma, Bangladesh, Indonesia (Java), Japan, Australasia and the Marianas. In Australasia it is known from eastern Australia (Qld, NSW), the Cook Islands, Fiji, New Zealand and Vanuatu. Very common in Norfolk Island.

**Specimens Examined:**

NORFOLK ISLAND. On base of *Araucaria heterophylla*, S1, JAE 18134, 18136, 18141, 18160, HS 31712 (B, H, LSU, US); on fence post, *Grevillea* and *Pinus*, S4, JAE 18204, 18220, 18251, HS 31798 (B), 31846 (B, H, US); on *Melia*, S4, JAE 18240 (*Lich. Australasici Exsicc.* Fasc. 4: 98), HS 31802 (H, US); on shrub and *Lagunaria*, S7, JAE 18359, HS 32006 (B, H, NY, US); on old fence post, S15, JAE 18704; on twigs of *Eucalyptus* and

volcanic rocks, S28, *JAE* 18526, 18528; on *Lagunaria*, S10, *HS* 32214; on *Araucaria* trunk, S15, *HS* 34579; on tree trunk, S25, *HS* 34878 (B, LSU); on stem of *Araucaria heterophylla*, S34, *HS* 34862; on *Elaeodendron curtispendulum*, 300 m west of Steeles Point, 29°02'S, 167°59'E, 100 m, *M. M. Richardson & G. Plant* 106 (CBG).

*Ramalina peruviana* Ach., *Lich. Univ.*, 599 (1810).

**Type:** South America, Peru, *Lagasta* s.n. (H-ACH-holotype; BM, UPS-isotypes); contains sekikaic acid aggregate, usnic acid (Stevens, 1987).

For further synonymy see Stevens (1987).

**Thallus** fruticose, corticolous, tufted, erect to subpendulous, pale green to grey-green, up to 6 cm long; branching subdichotomous to irregular, often intricate with the production of dense fragile branchlets; branch width 0.1-0.9(-1.5) mm, branches flat, compressed but becoming angularly subterete to terete towards the apices, branches often slightly twisted, apices sharp to blunt, often broken; surface matt, rarely shiny, smooth to rugose, weakly *pseudocyphellate* either basally or along the entire length, appearing weakly striate or ridged or subfenestrate in basal parts, sorediate; holdfast delimited or diffuse; *soralia* punctiform, numerous, marginal or lateral, sometimes apical, mounds of soredia often producing small fibrils. **Apothecia** rare, marginal, lateral, 0.5-2.0 mm diam., concave, margin thick, often crenate; spores eight per ascus, colourless, 1-septate, narrow, fusiform, straight or rarely curved, 14-16(-18) x 3.5-4.5  $\mu$ m.

**Chemistry:** Thallus K+ yellow, P-; containing homosekikaic acid (major), sekikaic acid (major), ramalinolic acid (trace), 4'-O-demethylsekikaic acid (trace), 4'-O-methyl-norsekikaic acid (trace) and usnic acid (minor/trace).

*R. peruviana* is widely distributed in warm temperate to subtropical regions of the Southern Hemisphere. In Australasia it is known from eastern Australia (Qld., N.S.W.), New Zealand and New Caledonia. Uncommon in Norfolk Island.

#### **Specimens Examined:**

NORFOLK ISLAND. On *Melia* and *Grevillea robusta*, S4, *JAE* 18242, *HS* 31853; on *Pinus*, S4, *JAE* 18252 (*Lich. Australasici Exsicc.* Fasc. 4: 99), *HS* 31815 (B, H, US); on *Citrus limon*, S12, *JAE* 18586, 18587; on *Melia*, S22, *JAE* 18803; on roadside tree, S26, *JAE* 18126; on tree trunk, S32, *HS* 34933.

*Ramalina stevensiae* Elix, *Mycotaxon* 40: 42 (1991).

**Type:** Norfolk Island. On *Citrus limon* in subtropical rainforest, summit trail to Mt Bates, 29°00'30"S, 167°56'30"E, 300 m, *J. A. Elix* 18582 & *H. Streimann*, 6.xii.1984 (CBG-holotype; MEL-isotype).

**Thallus** fruticose, corticolous, caespitose, erect or subpendulous, pale grey-green to pale yellow, often with a paler lower surface, 2-8 cm high, lacking soredia; branching subdichotomous to irregular, moderate to dense, with fragile branchlets towards the apices; branches (0.2-)0.5-1.0(-3.0) mm wide, compressed, flat to subcanaliculate, with attenuate apices, rarely with rounded laminal perforations to 0.5 mm diam.; cortex shiny, smooth, lacking soredia and pseudocyphellae; holdfast delimited or diffuse. **Apothecia** sparse to common, subterminal on geniculate branches or terminal on main and short lateral branches, spurred, or in the axils of bifurcating branches; disc 1.0-2.5 mm diam., concave to plane; margin entire; spores eight per ascus, colourless, 1-septate, ellipsoid, straight or often slightly curved, 10-13(-15) x 4-5  $\mu$ m.

**Chemistry:** Thallus K-, KC-, C-, P-; containing usnic acid, divaricatic acid (major), nordivaricatic acid (minor/trace), unknown terpenes (traces).

This species is characterized by compressed, narrow, intricately branched lobes and medullary divaricatic acid. *R. stevensiae* appears to be endemic to Norfolk Island and is quite common on forest trees at higher elevations.

### *Specimens Examined:*

NORFOLK ISLAND. On canopy of fallen tree, S8, *JAE 18415*; on mossy trunk, S24, *JAE 18821*; on fallen twigs, S26, *JAE 18122*; on dead wood, sin. loc., J. & J. Gilbert, 24-27.viii.1975 (HO); on *Citrus limon*, S12, *HS 34301* (B); on treelet stem, S14, *HS 34571* (B, CBG, H); on tree trunk, S22, *HS 36481* (B, CBG); on dead shrub, S24, *HS 34811*.

Previous reference to *Ramalina australiensis* Nyl., *R. canariensis* J. Stein., *R. celastri* (Spreng.) Krog & Swinsc. and *R. glaucescens* Krempelh. in Norfolk Island (Riedl, 1988) could not be verified as the specimens were not available for examination.

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### References

- ARCHER, A. W., 1986. — Nomenclatural notes on some Australian *Cladonia* species. *Lichenologist* 18: 241-246.
- CHRISTENSEN, S. N., 1987. — Morphological and chemical variation in the *Cladonia macilenta/bacillaris* aggregate in Denmark. *Lichenologist* 19: 61-69.
- ELIX, J. A., 1985. — Lichenes Australasici Exsiccati, Fasc. 4, no. 76-100. Australian National University, Canberra.
- , MUSIDLAK, H. W., SALA, T., and SARGENT, M. V., 1978. — Structure and synthesis of some lichen xanthoncs. *Aust. J. Chem.* 31: 145-155.
- , and STREIMANN, H., 1989. — The lichens of Norfolk Island. 1: Introduction and the family Parmeliaceae. *Proc. Linn. Soc. N.S.W.* 111: 103-121.
- FILSON, R. B., 1986. — Index to Type Specimens of Australian Lichens 1800-1984. Australian Flora and Fauna Series No. 4, Australian Government Publishing Service, Canberra.
- GALLOWAY, D. J., 1985. — *Flora of New Zealand. Lichens*. Wellington: Government Printer.
- , 1988. — Studies in *Pseudocyphellaria* (lichens) I. The New Zealand species. *Bull. Br. Mus. nat. Hist. (Bot.)* 17: 1-267.
- MAGNUSSON, A. H., and ZAHLBRUCKNER, A., 1944. — Hawaiian Lichens II. The Families Lecideaceae to Parmeliaceae. *Ark. för Botanik* 31A (6): 54-62.
- MÜLLER ARGOWIENSIS, J., 1884. — Lichenologische Beiträge XIX. *Flora Regensburg*, 67: 268-468.
- NOWAK, J., and TOBOLEWSKI, Z., 1975. — *Porosty Polskie*. Warsaw: Państwowe Wydawnictwo Naukowe.
- RIEDL, H., 1988. — Taxonomical and Phytogeographical Notes on some lichens from Norfolk Island. *Stapfia* 17: 273-286.
- STENROOS, S., 1988. — The family Cladoniaceae in Melanesia. 3. *Cladonia* sections *Helopodium*, *Perviae* and *Cladonia*. *Ann. Bot. Fennici* 25: 117-148.
- STEVENS, G. N., 1987. — The lichen genus *Ramalina* in Australia. *Bull. Br. nat. Hist. (Bot.)* 16: 107-223.
- YOSHIMURA, I., 1967. — Relationships between the Japanese and North American species of *Cladonia*. Knoxville, Tenn.: University of Tennessee, M.Sc. thesis, unpubl.